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DOI: <https://doi.org/10.3390/app10217408>

Posted at the Zurich Open Repository and Archive, University of Zurich

ZORA URL: <https://doi.org/10.5167/uzh-201198>

Journal Article

Published Version



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Originally published at:

Carraro, A; Gnech, M; Sarto, F; Spörri, Jörg; Masiero, S (2020). Lower Back Complaints in Adolescent Competitive Alpine Skiers: A Cross-Sectional Study. *Applied Sciences*, 10(21):7408.

DOI: <https://doi.org/10.3390/app10217408>

Article

Lower Back Complaints in Adolescent Competitive Alpine Skiers: A Cross-Sectional Study

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Received: 7 October 2020; Accepted: 19 October 2020; Published: 22 October 2020



Abstract: Background: Little is known about lower back complaints in adolescent competitive alpine skiers. This study assessed their prevalence and severity (i.e., intensity and disability) with respect to sex, category, discipline preference, and training attributes. Methods: 188 competitive skiers aged 15 to 18 years volunteered in this study. Data collection included (i) questions on participants' demographics, sports exposure, discipline preferences, and other sports-related practices; (ii) the Nordic Musculoskeletal Questionnaire on lower back complaints; and (iii) the Graded Chronic Pain Scale. Results: As many as 80.3% and 50.0% of all skiers suffered from lower back complaints during the last 12 months and 7 days, respectively. A total of 50.7% reported their complaints to be attributable to slalom skiing, and 26% to giant slalom. The majority of complaints were classified as low intensity/low disability (Grade I, 57.4%) and high intensity/low disability complaints (Grade II, 21.8%). The Characteristic Pain Intensity was found to be significantly related to the skiers' years of sports participation, number of competitions/season, and number of skiing days/season. Conclusion: This study further supports the relatively high magnitudes of lower back-related pain in adolescent competitive alpine skiers, with a considerable amount of high intensity (but low disability) complaints, and training attributes being a key driver.

Keywords: alpine skiing; athletes' health; epidemiology; spine; musculoskeletal injuries

1. Introduction

Competitive alpine skiing is a popular yet high-risk sport. At all competition levels, health problems are frequent [1–7]. In particular, lower back has been reported to be one of the most affected body regions for overuse complaints [8]. Adolescent competitive alpine skiers are also known to suffer from relatively high rates of radiographic abnormalities in the thoracolumbar spine [9]. Specifically, degenerative disc changes were observed to be more prevalent in adolescent competitive alpine skiers than in age-matched controls [10]. Moreover, a recent study found such disc degenerations (particularly disc dehydration and disc protrusion) to be significantly more prevalent in symptomatic than in asymptomatic athletes [11]. However, little is known about the prevalence

of lower back complaints in adolescent skiers with respect to severity (i.e., intensity and disability). Additionally, the role of discipline preference is widely unexplored as of yet.

The link between lower back pain and physical activity has been described as a U-shaped relationship, whereas increased risk was found for both sedentary subjects and those practicing strenuous physical activities [12]. According to this association, athletes may be considered a high-risk population, mainly due to the training and competition loads they are subjected to. Moreover, as a result of their musculoskeletal and spinal immaturity and excessive height growth, adolescent athletes are especially vulnerable [11,13].

From a biomechanical perspective, the following factors may contribute to overloading of the lower back structures in alpine ski racing [14]: (a) repetitive and heavy mechanical loads, particularly when accompanied by insufficient recovery between the training sessions [15]; (b) unphysiological postures (i.e., frontal bending, lateral bending, and torsion), associated with high ground reaction forces (up to 2.89 times the body weight) [16]; and (c) excessive exposure to low-frequency whole-body vibrations [17–20]. Since all of these factors are typical characteristics of alpine skiing-specific sports exposure, studying the relations between training attributes and lower back complaints is of superior importance.

Therefore, the aims of this study were: (1) to describe the demographics, sports exposure, and other sports- or warm-up-related practices of adolescent competitive alpine skiers; (2) to assess the prevalence of lower back complaints in this specific cohort with respect to sex, category, and discipline preference; (3) to explore their lower back complaints severity (i.e., intensity and disability); and (4) to investigate the potential relations with training attributes.

2. Materials and Methods

2.1. Study Design and Setting

This study was designed as a cross-sectional observation and was based on a structured and customized questionnaire package. Data were collected in the participants' sport clubs facilities at the end of the competition season. Questionnaires were spread physically. A member of the research team introduced the questionnaires to the participants, explaining all the questionnaire items and scales. Subsequently, the participants filled the questionnaires independently and individually.

2.2. Participants and Recruitment

Participants were included if they were members of ski clubs associated with the FIS (Italian Winter Sports Federation) Veneto region section and competed in the categories under 16 (U-16) and under 18 (U-18) years old. There were no study exclusions. All the ski clubs associated with the FIS Veneto region were contacted and invited to take part in the study. Finally, 188 adolescent competitive alpine skiers (110 males and 78 females) volunteered for the purpose of the current study; 128 belonged to the category U-16 and 60 to the U-18. The entire study sample represented about 70% of all U-16 and U-18 competitive alpine skiers affiliated to the FIS clubs in that region. The Ethics Committee of the Department of Biomedical Sciences of the University of Padua approved the study (HEC-DSB/02-19). Prior to the study, all the participants and their parents or legal representatives provided written informed consent. The participants did not receive any reward for their participation in the study.

2.3. Assessment Methods and Parameters

The questionnaire package comprised four parts: (1) questions on participants' demographics, sports exposure (years of sports participation, number of competitions/season, number of skiing days/season, number of athletic preparation days/season) and other sports- or warm-up-related practices; (2) the Nordic Musculoskeletal Questionnaire (NMQ), Italian version [21,22]; (3) specific questions on how their skiing discipline (e.g., Slalom—SL; Giant Slalom—GS; Super-G—SG;

or Downhill (DH)) was related to the occurrence of lower back complaints; (4) the Graded Chronic Pain Scale (GCPS), Italian version [23,24].

The NMQ aimed on investigating the time prevalence of musculoskeletal complaints in the lower back during the last 12 months and 7 days, respectively, as well as on whether these complaints resulted in any restrictions while carrying out normal activities or whether they required medical attention or not. Questionnaire completion was supported by a body map displaying the pain area. The GCPS was used to grade the severity of the lower back complaints. The underlying methodology consists of seven questions related to pain intensity items and disability items with respect to the 6 months preceding the questionnaire. Answers were provided on a scale from 0 (e.g., “no pain” or “no interference/change”) to 10 (e.g., “pain as bad it could be” or “unable to carry on any activity/extreme change”) [23]. Based on these scale points, as well as on a specific scoring system, the Characteristic Pain Intensity (0–100), Disability Score (0–100), and Disability Points (0–3) were calculated and, subsequently, were assigned to five severity grades, as described in Von Korff et al. [23]: Grade 0 (pain-free); Grade I (low disability—low intensity); Grade II (low disability, high intensity); Grade III (high disability, moderately limiting); and Grade IV (high disability—severely limiting).

2.4. Statistical Analysis

Participant demographics, sports exposure, and training/competition/other sports practices were expressed as the mean \pm SD and percentage proportions, respectively. NMQ-related measures and GCPS-based classifications were expressed as the absolute number and percentage of participants affected. The GCPS scores were described as the mean \pm SD. All the measures were presented for the entire sample and the subgroups based on sex (female and male) and competition category (U-16 and U-18). Prevalence was additionally described with respect to the discipline to which they were perceived as being attributable. Pearson’s Chi-squared tests were used to assess the potential sex and category differences in measures with percentage proportions at $p < 0.05$. Independent sample *t*-tests were used to evaluate the sex and category differences in interval scaled measures at $p < 0.05$. Pearson’s correlation analysis was performed on GCPS items and scores, as well as on the relationship between GCPS scores, years of sports participation, number of competitions/season, number of skiing days/season, and number of athletic preparation days/season. For any correlation analysis, statistical significance was set at $p \leq 0.05$.

3. Results

3.1. Participant Demographics, Sports Exposure and Training/Competition/Other Sports Practices

Male participants were characterized as follows: age: 16.1 ± 1.1 y; weight: 65 ± 10 kg; height: 1.74 ± 0.08 m; BMI: 21.5 ± 2.3 kg/m²; years of sports participation: 8.1 ± 2.4 y. The group of female participants had the following characteristics: age: 16 ± 1 years; weight: 56.2 ± 6.4 kg; height: 1.65 ± 0.05 m; BMI: 20.7 ± 1.9 kg/m²; years of sports participation: 7.1 ± 2.9 y. Over the past competition (i.e., winter) season, the participants reported a mean of 85.4 ± 47.2 days (3.5 ± 1.3 days/week) of ski training and participated in 17.2 ± 12.0 competitions on average. Independent sample *t*-tests revealed no significant differences between the sexes. However, there were significant differences in the number of skiing days/season ($t(186) = 2.18$, $p = 0.029$) and the number of competitions in the last season ($t(186) = 7.22$, $p < 0.001$) between the U-16 and U-18 categories, with athletes in the U-18 category who performed more skiing days and competitions. Most participants (62.8%) declared that they practiced one or more sports other than alpine skiing, 83.5% reported that they participated in specific athletic preparation programs, and 78.3% declared that they regularly warm-up before skiing. The Chi-squared tests revealed, however, no significant sex or category differences in these variables at $p < 0.05$.

3.2. Prevalence of Lower Back Complaints

An overview of the NMQ-related results is presented in Table 1. A total of 80.3% of all participants reported having suffered from lower back complaints during the last 12 months, and 50.0% during the last 7 days. As many as 28.2% reported that they have been restricted in normal activities (e.g., job and leisure activities) during the last 12 months, and 27.7% indicated that their lower back complaints required medical attention during the last 12 months. Except for lower back complaints during the last 7 seven days, which were more frequent in females, there were found no sex or category differences. Interestingly, 50.7% of the participants reported their lower back complaints being attributed to performing SL, 26.0% to GS, and 7.3% to SG; meanwhile, no participants attributed their lower back complaints to DH skiing. A remarkable season period-related difference in the frequency patterns of lower back complaints was found between the competition period and the off-season period. During the off-season period, only 3.3% reported their lower back complaints to last longer than two weeks, while during the competition period this percentage proportion was more than six times higher (21.3%).

Table 1. Overview of the Nordic Musculoskeletal Questionnaire (NMQ)-based results and differences between sexes and categories.

NMQ Measure	Overall <i>n</i> = 188	Male <i>n</i> = 110	Female <i>n</i> = 78	$\chi^2(\text{df}), p$	U-16 <i>n</i> = 128	U-18 <i>n</i> = 60	$\chi^2(\text{df}), p$
Lower back complaints during the last 12 months	(151) 80.3%	(89) 80.9%	(62) 79.5%	n.s.	(103) 80.5%	(48) 80%	n.s.
Lower back complaints during the last 7 days	(94) 50%	(42) 42.7%	(47) 60.3%	5.61(1) 0.018	(65) 50.8%	(29) 48.3%	n.s.
Restricted in normal activities during the last 12 months	(53) 28.2%	(31) 28.2%	(22) 28.2%	n.s.	(36) 28.1%	(17) 28.3%	n.s.
Required medical attention during the last 12 months	(52) 27.7%	(33) 30%	(19) 24.4%	n.s.	(35) 27.3%	(17) 28.3%	n.s.

All NMQ-related measures are expressed as absolute numbers and the percentage proportion on the overall group/subgroups (number of affected skiers/number of skiers per group \times 100). Levels of significance for sex and category differences are based on Pearson chi-square tests. n.s.: not significant at $p < 0.05$; U-16: under 16 years; U-18: under 18 years.

3.3. Severity of Lower Back Complaints

The GCPS-related results are summarized in Table 2. The mean value of Characteristic Pain Intensity was 37.53 ± 18.0 and the Disability Score was 13.27 ± 14.59 on average. There were no significant sex or category differences at $p < 0.05$. Most participants (57.4%) suffered from low intensity—low disability complaints (Grade I), and 21.8% from high intensity—low disability complaints (Grade II). Again, there were no significant differences between males and females, or between U-16 and U-18 skiers.

Table 2. Overview of the Graded Chronic Pain Scale (GCPS) scores and differences between sexes and categories.

GCPS Score	Overall <i>n</i> = 188	Male <i>n</i> = 110	Female <i>n</i> = 78	<i>t</i> (<i>df</i>), <i>p</i>	U-16 <i>n</i> = 128	U-18 <i>n</i> = 60	<i>t</i> (<i>df</i>), <i>p</i>
Characteristic Pain Intensity	37.53 ± 18.0	28.30 ± 21.98	32.26 ± 22.11	n.s.	30.62 ± 22.71	28.50 ± 20.70	n.s.
Disability Score	13.27 ± 14.59	11.29 ± 15.22	9.61 ± 12.32	n.s.	11.51 ± 15.06	8.64 ± 11.59	n.s.
GCPS Classification				χ²			
Grade 0 Pain free	(39) 20.7%	(23) 20.9%	(16) 20.5%	n.s.	(27) 21.1%	(12) 20%	n.s.
Grade I Low intensity-Low disability	(108) 57.4%	(64) 58.2%	(44) 56.4%	n.s.	(70) 54.7%	(38) 63.3%	n.s.
Grade II High intensity-Low disability	(41) 21.8%	(23) 20.9%	(18) 23.1%	n.s.	(31) 24.2%	(10) 16.7%	n.s.
Grade III High Disability-Moderately Limiting	—	—	—	—	—	—	—
Grade IV High Disability-Severely Limiting	—	—	—	—	—	—	—

GCPS scores are expressed as mean ± SD. GCPS classifications are expressed as absolute numbers and the percentage proportion of the overall group/subgroups (number of affected skiers/number of skiers per group × 100). Levels of significance for sex and category differences are based on independent sample *t*-tests and Pearson chi-square tests, respectively. n.s.: not significant at *p* < 0.05; U-16: under 16 years; U-18: under 18 years.

3.4. Relationship between Different Severity Measures, as well as between Severity and Training Attributes

We found a medium-correlation Characteristic Pain Intensity and Disability Score ($r = 0.62, p < 0.01$). Moreover, the average lower back complaint intensity, as well as the intensity at the time of filling out the questionnaire, positively correlated with the worst pain intensity experienced within the last 6 months ($r = 0.63, p < 0.01$; $r = 0.47, p < 0.01$, respectively).

The results of the correlation analysis between the GCPS scores and different training attributes are highlighted in Table 3. There were small yet significant correlations between the Characteristic Pain Intensity and the training attributes “years of sports participation”, “number of competitions/season”, and “number of skiing days/season”. Moreover, an additional independent *t*-test showed a significant difference ($t(186) = 2.12, p = 0.035, d = 0.31$) in the lower back complaint severity (i.e., GCPS—Characteristic Pain Intensity) between skiers who exclusively practiced alpine skiing and those who also practiced other sports, with the first group reporting higher intensities.

Table 3. Correlation between the Grading Chronic Pain Scale scores and questions on sports exposure.

	Characteristic Pain Intensity	Disability Score
Years of sports participation	0.28 **	0.15 *
Number of competitions/season	0.21 **	−0.02
Number of skiing days/season	0.27 **	0.12
Number of athletic preparation days/season	0.03	−0.09

Level of significance based on Pearson correlation analysis: * $p < 0.05$, ** $p < 0.01$.

4. Discussion

The main findings of this study were: (1) as many as 80.3% of all participating adolescent skiers suffered from lower back complaints during the last 12 months (50.0% during the last 7 days; 28.2% with restrictions in normal activities; and 27.7% requiring medical attention); (2) 50.7% of the participants reported their lower back complaints being attributable to SL, and 26.0% to GS; (3) despite the fact that the majority of the participants experienced lower back complaints of a low intensity/low disability (Grade I, 57.4%), a considerable portion suffered from a high intensity/low disability complaints (Grade II, 21.8%); (4) there were small yet significant correlations between the Characteristic Pain Intensity and the training attributes “years of sports participation”, “number of competitions/season”, and “number of skiing days/season”.

4.1. Prevalence of Lower Back Complaints with Respect to Sex, Category and Discipline Preference

The current study found relatively high rates of lower back complaints in adolescent competitive alpine skiers. Indeed, 50.0% and 80.3% of the participants displayed lower back complaints in the last 7 days and 12 months, respectively. These values are considerably higher than those previously reported for other populations. For example, a 12 months lower back pain prevalence of between 49.8% and 65.0% was observed in previous studies in elite athletes of different sports [25–27]. A 7 days lower back pain prevalence between 19.4% and 25.3% was reported for endurance athletes [25]. Previous works found a 12 months lower back complaints prevalence ranging from 20.5% to 57.0% in non-athletic adolescents [25,28,29], while a 7 days lower back complaints prevalence of about 20.0% was reported for young non-athletes [25].

The higher prevalence of lower back complaints observed in the present study compared to other athletic (and non-athletic) adolescents suggests that competitive alpine skiers are especially prone for lower back complaints. Indeed, in the sport of alpine ski racing, repetitive and heavy mechanical loads, high ground reaction forces, and the exposure to low-frequency whole-body vibrations have

been shown to adversely affect the spinal structures while skiing [14,16,17]. Moreover, in young skiers, the immaturity of the musculoskeletal system may exacerbate the damage experienced by the spine during the practice of this sport [13].

Despite these plausible sports-related adverse loading patterns, only a few studies, however, have investigated the occurrence of lower back complaints in competitive alpine skiers. Moreover, due to focusing on a different age group and reporting other time prevalence measures or absolute injury rates, most of them are not directly comparable to the results of the current study [3,4,6,8,11]. The only study directly comparable to our investigation reported similar magnitudes of current low back pain (67.0%) in ski high school athletes aged 15–19 years [30].

Noteworthy, in our study, a higher 7 days lower back complaints prevalence was observed in females with respect to males (60.3% vs. 42.7%). These results are in agreement with previous works and, on the one hand, may be explained by a different pain threshold and symptom perception between males and females [31,32]. On the other hand, this sex difference may also be explained by the different anatomical characteristics of the female body (e.g., greater spine flexibility), as well as the different pubertal growth and hormonal states [33,34].

Furthermore, our study revealed that, during the 12 months prior to data collection, 28.2% of the participants were restricted in carrying out normal daily life activities, while 27.2% needed to see a physician. This latter percentage is similar to the magnitudes found in previous studies (range between 24.0 and 33.0%) including large cohorts of children and adolescents [35,36].

Interestingly, we found different skiing disciplines to have different perceived impacts on lower back complaints. Indeed, 50.7% attributed their lower back complaints to SL, while 26.0% reported to have suffered them in connection with GS and 7.3% with SG. None of the participants attributed their lower back complaints to DH. A possible explanation is that, in SL, there are more pronounced and larger ground reaction force peaks (approximately plus 20.0%) after gate passage than in GS [37].

Regarding the prevalence of lower back complaints according to the annual programming period, we found that the prevalence of lower back complaints lasting less than 7 days was 86.0% in the off-season and 33.3% in the competition season. Conversely, the frequency of lower back complaints lasting more than two weeks changed from 3.3% in the off-season to 21.3% in the period of the competition season. This fact may suggest that more severe lower back complaints emerge from skiing rather than from off-snow training [3].

4.2. Severity of Lower Back Complaints with Respect to Intensity and Disability

Another aim of this work was to study the severity (i.e., pain intensity and disability) of lower back complaints in adolescent competitive alpine skiers. Despite the fact that most of the participants (57.4%) reported low intensity—low disability complaints (Grade I of the GCPS), 21.8% showed high intensity—low disability complaints (Grade II). These findings showed that a considerable part of the participants suffered from a relatively high severity of lower back complaints already at a relatively young age (15–18 y). However, the pain resulted in being of low disability, which is in agreement with previous studies in adolescent athletes [25,38]. One potential explanation for this finding may be the consideration that the cohort of the current study consisted of relatively young athletes, who may not have suffered from an extensive accumulation of adverse loadings over time yet.

4.3. Relationship between Lower Back Complaints Severity and Training Attributes

The current study revealed small yet significant correlations between Characteristic Pain Intensity and the training attributes “years of sports participation”, “number of competitions/season”, and “number of skiing days/season”. These findings further support our current understanding of the development of lower back overuse injuries, according to which an accumulation of adverse loadings on the athletes’ spine is a key driver for inducing pain [16]. However, the present sample was homogeneous with respect to training attributes, since the participants of our study belonged to ski

clubs of the same region. Therefore, the results of this study may be specific to our cohort and should be interpreted with caution.

4.4. Methodological Considerations

Despite providing valuable new insights into the prevalence and severity of lower back complaints in adolescent competitive alpine skiers, this study has some limitations that one should be aware of. First, the retrospective nature of the NMQ and GCPS methodologies may cause them to suffer from a recall bias. Recent and more severe complaints are more likely to be remembered than older and less severe ones. Second, the background and experience of the participants filling out the questionnaires may influence the outcomes. Third, other potential cofounders for lower back complaints, such as smoking, hours of sleep per night, and psychosocial factors (depression, stress, poor academic performance, poor competitive results, etc.), were not evaluated in this study.

5. Conclusions

This study provides a new set of data regarding the prevalence and severity of lower back complaints in a sample of adolescent competitive alpine racers. It further supports the relatively high magnitudes of lower back-related pain, with a considerable amount of high intensity but low disability complaints. Interestingly, more low back complaints were reported during SL and GS than other skiing disciplines. Moreover, this study further highlights an accumulation of adverse loadings on the athletes' spine being a key driver for developing pain conditions. Accordingly, adolescent competitive alpine skiers should be particularly protected by rigorous prevention strategies already before reaching adolescence.

Author Contributions: Conceptualization, A.C., D.S., and S.M.; investigation, M.G.; resources, D.S. and M.G.; data curation, A.C., F.S., and M.G.; writing—original draft preparation, F.S., M.G. and J.S.; writing—review and editing A.C., J.S., and S.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: The authors would like to thank the participants for their kind participation and their coaches, ski clubs, and the FISI Veneto Committee for supporting and facilitating the completion of this study.

Conflicts of Interest: The authors declare no conflict of interest.

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